

THE PROBLEM OF THE UNIT HEREDITARY FACTOR OR GENE.

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Genetic analysis has demonstrated that the hereditary differences between individuals are due to unit hereditary factors or genes which are segregated in the gametes and recombined in each generation. Cytological study has revealed the chromosomal mechanism by which these segregations and recombinations are accomplished. With these demonstrations the central problem of genetics has shifted to the genes themselves, just as in physics and chemistry it shifted from the recombinations of atoms to the internal structure of the atom.

The gene is being attacked from two sides, first through the study of the causes of gene change or mutation and second through the study of the somatic effects produced by the gene before and after mutation and the comparison of these effects with those produced by the direct effect of environmental agents upon the soma.

Most genes are remarkably stable, remaining unchanged for long periods. A gene undergoing change within a hundred years has an unusually rapid rate of mutation. In a few cases only, has it been possible to measure the rate in a particular gene. One of these is that of bar eye in the fruit fly *Drosophila*. About one individual in 1600 shows a change in this gene. Environmental agents such as temperature affect the rate only to the extent to which they affect the length of the individual life cycle. The number of mutations within normal environmental ranges is proportional to the number of individuals produced by any particular environmental condition and it seems therefore that mutations may be due to certain critical transformations such as the reduction in the number of chromosomes. These processes may go wrong occasionally and thereby alter the structural basis of a gene.

There is no indication of modification of the gene correlated with the somatic effect of an environmental factor. We have had the descendants of a single pair of flies of an inbred line in two groups one at 17 degrees centigrade and the other at 27 degrees for nearly six years. This length of time represents 141 gener-

ations at the higher and 57 at the lower temperature. The eyes of the flies raised at 17 degrees are over twice as large as those raised at 27 degrees. Yet when flies from both sources are raised at the same temperature they are indistinguishable. The gene for bar-eye is unchanged by the environment to which it has been subjected. There is no inheritance of the somatic temperature effect.

However when genes are subjected to the violent action of X-rays and the dosage is regulated so as to be just under the fatal amount, gene mutations may occur with startling frequency. In Muller's experiments the rate was increased 150 times. We seem to be on the verge of rapid production and control of gene changes and with such a control over the units of heredity we will be able to guide the course of evolution in any desired direction.

The other angle from which the problem of the gene is being approached is that of the comparison between the effect of environmental factors upon the nature of somatic characteristics and the effect produced by a change in a gene.

In bar-eye of *Drosophila* the temperature at which the larva is raised has a marked effect upon the eye. A change of about nine per cent is produced by a change of one degree centigrade and it has been shown that this effect is confined to a period of a few hours during the early larval period. When there is a mutation in the bar gene there is a change in the size of the eye and also a change in the temperature coefficient and in one case a reversal of the direction of the effect. In the presence of the bar gene the eye *decreases* in size with increase in temperature and in the mutant *infrabar* it *increases* with increase in temperature as shown by Luce. An analysis is being made of the developmental processes with a view to the determination of the chain of cause and effect from the gene to the somatic character. Such an attempt is being made through the cooperation of several investigators in our laboratory and it is hoped that the results will throw light not only on the nature of the gene and the method of gene mutation, but also on the central problem of embryology, the manner in which somatic differentiations arise from the original structure of the egg and spermatozoon.